Coursera Statistical Inference Project

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6/28/2018

ToothGrowth analysis

Load the ToothGrowth data and perform some basic exploratory data analyses

The ToothGrowth dataset is described here. 60 guinea pigs received vitamin C in either orange juice (OC) or ascorbic acid (VC) and one of three doses (0.5, 1, and 2 mg/day).

The ToothGrowth dataframe contains 3 columns, odontoblast length (len), supplement type (supp), and supplement dose (dose). Each combination of treatment and dose has 10 measurements. Tooth growth follows a roughly slightly right-skewed distribution.

```
dim(ToothGrowth)
```

```
## [1] 60   3
```

```
head(ToothGrowth)
```

```
##     len supp dose
## 1   4.2   VC  0.5
## 2  11.5   VC  0.5
## 3   7.3   VC  0.5
## 4   5.8   VC  0.5
## 5   6.4   VC  0.5
## 6  10.0   VC  0.5
```

```
summary(ToothGrowth)
```

```
##       len          supp         dose
##  Min.   : 4.20   OJ:30   Min.   :0.500
##  1st Qu.:13.07   VC:30   1st Qu.:0.500
##  Median :19.25           Median :1.000
##  Mean   :18.81           Mean   :1.167
##  3rd Qu.:25.27           3rd Qu.:2.000
##  Max.   :33.90           Max.   :2.000
```

```
table(ToothGrowth$supp,ToothGrowth$dose)
```

```
##
##       0.5  1  2
```

```
##    OJ   10 10 10
##    VC   10 10 10
```

```
hist(ToothGrowth$len)
```

## Histogram of ToothGrowth$len
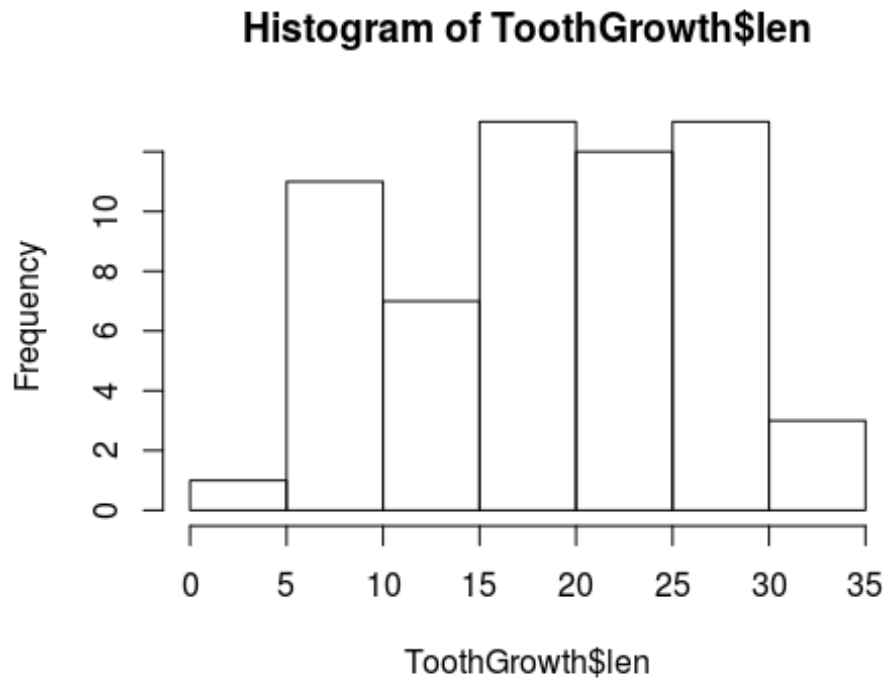
Provide a basic summary of the data

The mean and standard deviation of tooth growth for each combination of supplement type and dose are provided in the table below. They are also plotted as histograms.

```
ddply(ToothGrowth,.(supp,dose),summarise,Mean=mean(len),SD=sd(len))
```

```
##    supp dose  Mean       SD
## 1   OJ  0.5 13.23 4.459709
## 2   OJ  1.0 22.70 3.910953
## 3   OJ  2.0 26.06 2.655058
## 4   VC  0.5  7.98 2.746634
## 5   VC  1.0 16.77 2.515309
## 6   VC  2.0 26.14 4.797731
```

```
ggplot(ToothGrowth,aes(x=len)) + geom_density() + facet_grid(supp~dose)
```
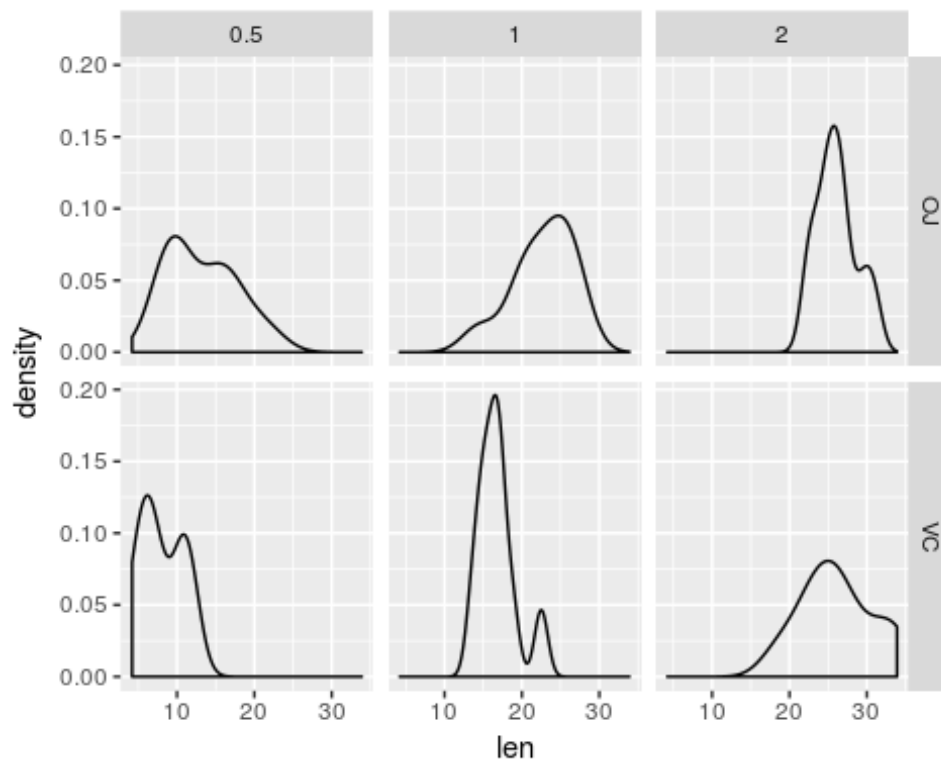
Use confidence intervals and/or hypothesis tests to compare tooth growth by supp and dose

A hypothesis test comparing tooth growth by supplement type using a two-sample Student's t-test indicates that the difference between the two supplement groups is not significant at an alpha level of 0.05 (p-value 0.06). However, when the test is performed at each dose, both the 0.5 and 1 mg/day dose levels have p-values of $< 0.05/3$, an alpha level of 0.05 adjusted for three comparisons using the Bonferroni correction. I also compared tooth length within supplement types between doses. At an alpha level of $0.05/6$ (adjusted for six comparisons), the only comparison that is not significant is 1 vs. 2 mg/day for OJ.

```
t.test(len~supp,data=ToothGrowth)
```

```
##
##  Welch Two Sample t-test
##
## data:  len by supp
## t = 1.9153, df = 55.309, p-value = 0.06063
## alternative hypothesis: true difference in means is not equal to 0
## 95 percent confidence interval:
##  -0.1710156  7.5710156
## sample estimates:
## mean in group OJ mean in group VC
##         20.66333         16.96333
```

```
ddply(ToothGrowth,.(dose),summarise,Pvalue=t.test(len~supp)$p.value)
```

```
##   dose      Pvalue
## 1  0.5 0.006358607
## 2  1.0 0.001038376
## 3  2.0 0.963851589
```

```
ddply(ToothGrowth[which(ToothGrowth$dose %in% c(0.5,1)),],.(supp),summarise,P
value=t.test(len~dose)$p.value)
```

```
##   supp       Pvalue
## 1   OJ 8.784919e-05
## 2   VC 6.811018e-07
```

```
ddply(ToothGrowth[which(ToothGrowth$dose %in% c(1,2)),],.(supp),summarise,Pva
lue=t.test(len~dose)$p.value)
```

```
##   supp       Pvalue
## 1   OJ 3.919514e-02
## 2   VC 9.155603e-05
```

```
ddply(ToothGrowth[which(ToothGrowth$dose %in% c(0.5,2)),],.(supp),summarise,P
value=t.test(len~dose)$p.value)
```

```
##   supp       Pvalue
## 1   OJ 1.323784e-06
## 2   VC 4.681577e-08
```

State your conclusions and the assumptions needed for your conclusions

Based on the above results, vitamin C provided via orange juice results in significantly greater tooth growth than vitamin C provided as ascorbic acid at 0.5 and 1 mg/day doses, but not 2 mg/day. For both supplement types, a higher dose of vitamin C almost always results in significantly greater tooth growth. These conclusions assume that all guinea pigs were treated equally. Furthermore, no control with only orange juice was performed; the study assumes that no additional vitamin C was provided by the vehicle.